ON THE BDELLOID ROTIFERA OF SOUTH AFRICA.

PART I.

By W. Milne, M.A., B.Sc., F.R.S.E.

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Plates 2–6.

The material for this paper has been gathered intermittently during the last ten years. A few of the species described are aquatic, but the large majority are moss-dwellers. The aquatic species are probably very numerous in South Africa, but little attention was paid to them.

Only a few meagre lists of South African *Bdelloida*, with no description of new species, had been published when in 1911 Murray's *Bdelloid Rotifera of South Africa* (11) * was issued. He mentioned fifty-three species as having been found, and tabulated forty which he had himself seen. Of these forty I have seen all but seven, and of the other thirteen I have seen ten.

I have been enabled to widen the scope of this paper by the help of several friends, who provided moss from parts inaccessible to me, and I have much pleasure in naming species after them.

I have had much correspondence with Mr. Bryce, and feel greatly indebted to him for assistance freely given. I received also from Mr. James Murray many helpful suggestions.

Mr. Bryce (6) has done a great service to students of *Bdelloida* in publishing his new classification. He has brought order out of what was fast becoming chaos. His classification is an excellent piece of work. I have only one small objection to make, and that is to a name. Mr. Bryce has proved conclusively that *C. elegans* (Ehr.) was certainly different from the short-footed species, which have usually been termed *Callidina*, therefore it follows that the genus *Callidina*, founded on that species, cannot include the short-footed ones. At one time I

* *Note.*—The figures in brackets refer to the Bibliography.

(2) thought *C. elegans* (Ehr.) was really *Adineta*. That is probably a mistake. At any rate I was satisfied that *Callidina* (Ehr.) could not include the short-footed species, and so I constituted a genus, *Macrotrachela*, for them. Ehrenberg's genus is not necessarily done away with.

The definition for *Macrotrachela* first given still applies, with an addition rendered necessary owing to Mr. Bryce's removal of the pellet-makers into a new genus—a thoroughly sound proceeding—*Macrotrachela* :—*Bdelloida* having three toes; foot shorter than the pre-intestinal part; oviparous; and not pellet-makers.

I shall in this paper, therefore, place all species which answer to this definition under the above genus.

Harring (12) has taken the same view with regard to the name of the genus.

The genus *Habrotrocha* is growing into a very large and unwieldy group, so I have taken this opportunity to separate some, and place them in a new genus, *Otostephanos*. They are different from all the others in that they possess a ring of fair thickness round the corona, with short breaks ventrally and dorsally. Murray's *H. auriculata* (10) which I have known for several years, is one of them. I have three other species to describe.

In the description of species I generally mention the nature of the lamella. Some writers consider that there are two separate lamellae, at least in some species. I have never been able to make out more than one. There are several undoubted instances of a single hood-like lamella, without any indentation whatever, as in *H. cucullata* (Murray). The common form has a sharp fold in the middle of the lamella, giving it a double appearance, but not with two separate parts. There are some which seem to me to have a double fold, giving in certain positions a triple lamella, as in *P. grandis ;* and others with a triple fold giving a quadruple lamella, as in *M. russeola* and *M. Ehrenbergi*. The ear processes mentioned by Janson (3) as part of the rostral sheath in the latter, are part of the lamella.

I have made some general remarks on the jaws of *Philodina*, which will be found under the description of *Monoceros falcatus*.

In 1906 my attention was drawn to a small animal, chiefly through the odd appearance of a bunch of large appendages,

posteriorly. It was soon apparent that there were other abnormalities about the creature, and that it was so aberrant—although an undoubted Bdelloid—that it could not be placed in any of the three families as given in Bryce's classification of the *Bdelloida* I have therefore constituted a new family for this animal :

MONOCEROTIDAE fam. nov.,

Bdelloida having, on the penultimate segment of the foot, one spur only.

The MONOCEROTIDAE differ from all other known *Bdelloida* in possessing only one spur. That they are Bdelloids, I think there can be no doubt. In their habits they resemble MICRODINIDAE and ADINETIDAE, but on the whole come nearest to MICRODINIDAE ; but the differences are very great. The jaws in each are abnormal, but not of the same type. The corona is very meagre in MONOCEROTIDAE, but wanting altogether in MICRODINIDAE. Both possess four toes, but in MONOCEROTIDAE the toes have each a separate external sheath.

In all other details, not already referred to, there seems to be no great difference from *Bdelloida* in general.

MONOCEROS gen. nov. *

Generic Characters.—Having one spur only ; four toes, and a fully developed rostrum. The corona is inconspicuous or obscure. Jaws are abnormal.

Two small circular arrangements, with not the slightest semblance of pedicels, situated on a prone face, represent the corona in *Philodina*. The gullet is extremely short.

Monoceros falcatus sp. nov.

Pl. 2, figs. 1–1*d*.

Specific Characters.—Rostrum well developed, with strong cilia. Corona inconspicuous—a sessile rotulate arrangement bearing rather feeble cilia on the rims and possibly no cilia

* Since the above was in type I have learned that the generic name Monoceros is already pre-occupied and according to the rules of nomenclature is ineligible; this also applies to the ordinal name as well. It is intended to rectify the error in Part II of this paper.

posteriorly. Gullet extremely short. Jaws quite abnormal. A short tube from the mastax, dorsally, leads into a large stomach mass. The foot is very stout, and tapers very little—possibly of four segments. Toes four, sickle-shaped, exceptionally long, each in its own large sheath. One large spur, dorsally placed; broad at the base, curving outwards slightly and then inwards to a point.

Antenna about as broad as long—with scrubby setae. There is a large brain mass, situated above and behind the mastax, branching off anteriorly into the antenna and forward, apparently into the rostrum. Intestine large, and contractile vesicle not very conspicuous. Foot glands are large. Size, 1/120th inch.

Monoceros falcatus is quite small and of a pale glaucous colour. The most striking feature is the posterior of the foot, with its four great sickle-shaped toes and the large spur; looking, when all planted downwards, as if supported on a banana-like bunch of props. I should probably have overlooked the first specimen had it not been for this odd appearance. The extended toes and the spur are not unlike each other, and at first I thought there were three spurs and two toes. They look altogether too big for the animal, and give it a far from graceful appearance. The spur and the extended toe are of about the same length, and equal to about one-eighth of the out-stretched animal. When feeding in the open, it may be seen with all four toes extended and planted on the glass; it has then a very peculiar appearance, as if resting on four props or stilts; and stranger still is the appearance when it uses the spur as a fifth prop. It occasionally may be seen balanced on the spur alone, but very rarely are the toes all withdrawn at the same time; two is the commonest number extended, and these the two next the spur. The tip of the toe is very small, and when it is withdrawn the sheath invaginates to about half its length, when it reminds one of a cylindrical bag, or a suspended knickerbocker leg, slightly longer than broad. It is a rather grotesque sight to see the four great cylindrical bags pendant alongside each other. The toe tips may usually be seen peeping out in the middle. Occasionally a toe may be shot out with great force. The toe muscles are exceedingly strong, and when extended the whole is very taut and rigid. Each toe has its own sheath, and can act independently of the others. When exserted, the toes are planted well apart, and can be seen projecting outside

the body width, and the tips form the corners of a figure, almost a square. The convex bend of each sickle is outside, and the inner concaves face each other diagonally. The spur is of elliptical form, and is motile at the base, at least it can be bent downwards.

The rostrum is of the usual Philodine type, and is short and stout. It has a double frontlet, and bears long cilia, which are more powerful than those of the corona. It is capable of taking an extremely firm hold. When the animal is feeding, the rostrum is not tossed over.

The corona might be looked on as decadent, with the whole—wheels and pedicels—reduced to thin discs; or—what is much more probable—as rudimentary, and advanced half-way in the evolution of a corona of the *Philodina*-type, from a prone face of the *Diglena*-type.

On the ventral face of the post-rostral segment, is seen a double rotulate arrangement, somewhat like two thin discs inset in the surface, and barely rising above it. These project very slightly, right and left, over the segment, and probably bend slightly towards each other. There is a narrow space or alley between. Along the rims of these discs, cilia are borne up the centre and round towards the posterior, where the discs are not well defined and the cilia are not visible. Just here—at the back of the wheels—the body depth increases in the ventral direction, and, projecting almost over the posterior of the discs, prevents a clear view of the back of them. This high boundary determines the oral entrance, into which the alley between the discs leads. This alley, down which the current streams, would thus be analogous to the sulcus in *Philodina*.

The gullet is extremely short, as the jaws come almost to the orifice, but do not project. There is a short oesophagus, similar to that seen in some species of Ploima between the mastax and the stomach.

M. falcatus is closely plicate, and many samples are so wrinkled and reticulated that the optical difficulties are increased to such an extent as to make it almost impossible to see the internal parts. These wrinkled specimens are usually seen after the water has been kept for a day or so. Seldom are live specimens found after the second day in the bottles, even when the water has been aerated periodically. This, taken with the fact that

their habitat is in rushing water, seems to indicate that a plentiful supply of oxygen is necessary.

The shape is variable; even when creeping it may keep the trunk fairly stout, or may attenuate it to a very considerable degree.

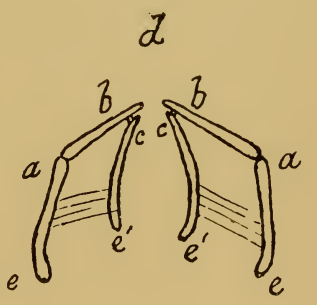
M. falcatus has two methods of progression. It has the ordinary leech-like manner of creeping, when it takes a very firm hold with the rostrum, draws up and plants the foot with a rabbit-like hop, and then shoots forward the head again. Its speed is by no means great, and in the open it usually takes but one or two hops at a time, then squatting on two, or it may be four toes, it keeps on swaying the head only, up and down and all round in a restless way, with the cilia of the corona and rostrum vibrating energetically, and the jaws in motion. It can also proceed by swimming, but in a rather helpless rolling sort of way. It aids the effect of the cilia by contractions of the body, and even then the motion is little more than visible. In its habitat, where the water flows swiftly, its power of swimming would be practically useless to it when dislodged from the moss.

It seems to be most at home when creeping about in the moss. It hops from branch to branch, the head searching tirelessly all about. Every now and then the rostrum is pushed hard against the moss, when with a decided snap it may be successful in breaking off some particles; it then bends the rostrum down over the corona, and thus with the aid of the cilia, which vibrate furiously, guides the food towards the oral entrance. Frequently when exploring the moss, it jerks back its head at the most unexpected times, a most irritating habit, which also characterises the Adinetae, whose manner of feeding is somewhat similar. It is a great gymnast and seems to enjoy itself most thoroughly when, attached by perhaps two toes high up on the rubbish, it happens to throw its head and body out into the open. It squirms and contorts itself into most fantastic shapes, without the least impression on the foothold. The muscles of the toes and the robust foot are so powerful that it can maintain itself for any length of time, straight out and tense—with no support but the toes—notwithstanding the extraordinary contortions of neck and trunk indulged in; and quivering all the while with excitement and pure pleasure. At times it sways round with the toes as a pivot, and without the slightest sagging in the general

horizontal direction. Without losing its hold, it may even bend its body quite round on itself, and search with the rostrum along the moss and rubbish to which the toes are attached, scraping off particles as already described. It can search in this way, without once shifting its hold, a circle of which its body is the radius—a provision of great service to it, as it lessens the chances of its being swept away by the swift current in which it lives.

There are the usual telescopic joints on the foot and neck, and though these slip out and in at times, I do not remember ever having seen one contracted into a ball. Dead specimens are always fully extended, with two toes showing the sickle shape, and two contracted into their sheaths.

The jaws at a first glance seem to be of the nature of some of the PLOIMA, but are quite different. They are in two parts (right and left) exactly alike, without any connecting single fulcrum. The mallei are of the simplest, consisting of two rods jointed together, both mallei being in the same plane. In the normal jaws nearest in general appearance, *e.g. Albertia*, the central rami and fulcrum are united together and form one part. In *M. falcatus*, however, the fulcrum has been, as it were, cut in two. There are thus two exactly similar portions (right and left) quite separate from each other, and accordingly different from any arrangement obtaining among the PLOIMA. Each fulcrum has become an exceedingly short and minute rod, visible only under very favourable circumstances. It is transposed to the anterior and lies between the uncus and ramus ends, articulated or muscularly attached to each. There is evidently a glassy plate connecting *ae* and *ce*[1], for in some of the larger examples several fine striae were seen between, thus indicating a link with the *Philodina* jaws.



The jaws seem to have two actions: a blinking, pecking action, somewhat like that of some of the Notommata; and a slightly rotating one, a little approaching that of *Philodina*, but jerky instead of the even, steady motion of the latter.

The nibbling, pecking action would be produced by the shooting forward of the two halves towards *d*, without any rotation or alteration of the direction of the planes *a c e* e^1; and then reversing the action. The rod *ab* has considerable freedom at the point *b*.

The second action seems to be produced in something like the following way. When the rods *ae* are pushed inwards and downwards, the rami *c* e^1 will bear on each other at the top ends, and as the pushing is continued will rise upward and forward—*a c e* e^1 being rigid planes—and *b* will be shot forward towards *d*; the whole action producing a grinding, rotating and forward movement at the front of *c* e^1. The point *e* in the above action apparently approaches e^1 but does not in reality, for as *e* goes down e^1 rises, giving the rotating movement which would not be possible if the planes *a c e* e^1 were not rigid.

When the reverse movement takes place, *b*, *b* may be brought down as far as to bring the unci in a straight line, throwing particles that may have been caught on to the grinding surfaces of the front ends of the rami and possible parts of contact below.

It seems to me that there are here all the elements of the *Philodina* jaws. The two halves of the jaws of *M. falcatus* represent the framework of the *Philodina* subquadrate parts; all the evolution required would be a thickened margin to the glassy plate between, and soldered on to *e* and e^1; the joints in the mallei soldered; the rami and unci points muscularly connected; and the minute rods thrust under, and thus taking the position of the double fulcrum in the *Philodina* jaws.

In the *Philodina* jaws the only parts soldered together at the front and back of each half are the borders of the surface which carries the teeth, they at least appear so. The ends of the rami are only muscularly attached. I can find nothing at all that could be considered a fulcrum where Gosse (1) represents it to be. The fulcrum of Ploima is represented here by two chisel-faced teeth (Pl. 3, fig. 3*e*) opposing each other, one on the keel of each ramus about one-third back from the anterior. Strong muscles connect them with the front of the jaws. The outside borders of the surfaces carrying the teeth and the striae are the mallei, and the inside opposing faces, each of which appears somewhat like a triangular file in shape, represent the rami. Round the jaws are three great muscular masses, two from the front

round the shoulders and backwards, and one from behind and under. I have seen what I took to be a muscle attached to the bottom mass and branching upwards into two which are fixed, one each, to the posterior ends of the rami. When the jaws begin to act, the first motion is usually a downward one in the centre. This would be caused by the pulling of the branching muscle referred to. As the pulling is continued, the chisel-faced teeth are ground against each other and downwards, and throw up the mallei. Then the muscles from the shoulder muscular masses act, and pull the mallei down; the chisel-faced teeth oppose each other at their lowest points, and throw the inside faces of the jaws (rami) up and away from each other with a slight rotation, as the front ends of the jaws are muscularly connected while the posterior ends are free. The jaws separate so far in *P. grandis* that when open the chisel-faced teeth can be seen between them from above. In each up-and-down motion the shock can be observed, just when the full pressure comes to bear on the opposing chisel faces. The resulting slight rock on the point of pressure can be seen.

The position of *Monoceros falcatus* seems to be somewhere between Ploima and *Philodina*. There are features which seem to show that it might very well have been evolved from free-swimming ancestors among the Ploima. The jaws, corona and spur might have come from some tailed form of *Pleurotrocha*. Probably there were parallel roads attempted from Ploima to *Philodina*. *M. falcatus* on one of these failed to get all the way, and *Microdina paradoxa* also failed on another road.

One is tempted, at this stage, to look for signs, among the *Bdelloida*, of any links towards other branches of the Rotifera. There are the horn-like processes of the corona of *Ceratotrocha cornigera*, which might point the way to the Flosculariа, possibly the farthest advanced of the Rotifera, as one of them, *F. moseli* (5), has rudimentary kidneys and is thus probably the highest of all.

Habitat.—Not far from Algoa Bay, to the west along the coast, are the grass-covered Cape flats. Walking across these flats near the farm of Draaifontein, one suddenly comes on a narrow, deep ravine, whose existence was quite unsuggested by the flat surroundings. On descending to the bottom, through the scrub and trees, a little stream is found, whose banks are covered

with maidenhair and other ferns. The ravine is not long, and meets with another larger one at right angles. Within a few feet of the junction, a large rock crosses the bed of the smaller ravine, and slopes steeply down stream. Over this declivity, which is covered with moss, the water glides swiftly. On this moss-covered slope is the home of *Monoceros falcatus*, and there it literally swarms. For several years I found it there without fail; then for two or three years I thought it had disappeared, as I could not find a single specimen in the moss brought to me from the ravine. It then occurred to me that the waterfall had been missed, so on the next opportunity I had the moss taken from the rock, and sure enough the animal was again found in abundance. It seems that it requires swiftly flowing water to thrive, at any rate this rock was the only place where I found it flourishing.

Family Philodinidae.

DIDYMODACTYLOS gen. nov.

Generic Characters.—*Bdelloida*, having two toes only.

Didymodactylos carnosus sp. nov.

Pl. 2, figs. 2–2*c*.

Specific Characters.—Large and massive; corona one-half wider than collar. Antenna very short; no eye-spot. Investment of stomach yellowish. Foot very short, of four segments. Spurs short, straight cones rising out of great globular or spherical bases without interspace. Toes, two. Teeth, four or five. Size, 1/50th inch.

This is a handsome animal, so Philodina-looking that I took it for one without suspicion, until I caught sight of the toes, and became aware that it had only two, distinct and well developed, and with no signs of any reduction. They are extruded from a narrow rectangular orifice, and can be seen extending through the sheath (Pl. 2, fig. 2*b*). In 1886 (2) I pointed out that the number of toes formed a very natural means of generic distinction; and as that method has been utilised by Bryce in his classification, it followed that a new genus was rendered necessary for this animal.

The corona is very wide and attractive, and equal to about one-fourth of the length of the animal when creeping and fully ex-

tended. It is one-half wider than the collar and twice as wide as the neck. The sulcus width is about three-fourths that of each disc, and is fully occupied by the boldly outlined and characteristic upper lip, consisting of two fine lobes and an intervening part with a boldly notched anterior border. It is rather difficult to get a good view of the corona, as the head is kept moving ceaselessly when feeding. Even when creeping, it has a restless, jerky, fussy manner. Though it does not get over the ground very fast, it is very forceful, and brushes its way under and through the rubbish with great vigour.

The rostrum is stout and fairly long, and has a triple arrangement of the lamella. There is a well-marked rosette round the closed mouth. The antenna is a mere stump, about one-sixth of the neck width. There are no eye-spots on the rather large brain mass.

The jaws are relatively small, and are crossed by four or five teeth of no great size. There is great difficulty in making quite sure of the number of teeth, on account of the restless habits of the animal and the density of the integument and parts overlying the dental bulb. There is a large gland below the mastax, darker in colour and finely granulated. The lumen is narrow and has a yellow investment. The intestine is large, and the contractile vesicle small and of short period.

The rump is well marked off from the trunk and is heavy. The foot is cleanly modelled, very short and equal to about one-twelfth of the total length. The second and third segments are each very short. The foot glands are very heavy and extend well up through the anal segment. The spurs are very distinctive and handsome; the great globular bases are quite unique, and the short cones seem set into them.

The foot and trunk are delicately and closely stippled.

The only Bdelloid nearly related to this is *Mniobia tetraodon*. In some points there is a considerable resemblance between the two. The samples of *M. tetraodon* which I have seen agree with those found by Bryce in the upper lip and size, but are more in accord with Janson's account (3) in the spread of the corona. I find cases of corona to collar as 15 : 14. In some the proportion was slightly greater, but none showed so great a proportion as Bryce mentions. The upper lip in mine agrees with Bryce's description (4). The upper lips in the two species are not very

different and each has a very short antenna. *D. carnosus* has a wider spread of corona, a more opaque integument, and is more massive, more especially towards the rump. It has four segments in the foot, while *M. tetraodon* has three as stated by Janson. The bases of the spurs in *M. tetraodon* are not globose but irregularly swollen, seen best ventrally towards the middle, and are relatively smaller. The spurs of *M. tetraodon* are curved and longer. In *D. carnosus* the two toes are distinct (fig. 2*c*); in *M. tetraodon* there is but a suggestion of two toes, caused by a slight pinch on one side, but the two parts on either side of this pinch never alter their relative positions towards each other, when exserted, which they would do if there were two toes. *D. carnosus* is of a much livelier disposition. *M. tetraodon* would seem to be a divergence from *D. carnosus* or some common ancestor.

Habitat.—Ground moss found growing very sparsely in grass at Springfield near the river, Uitenhage district. It was exposed to the broiling sun, and subject to long droughts. Very rare.

Genus PHILODINA (Ehr.).

Philodina praelonga sp. nov.

Pl. 4, figs. 5–5*b*.

Specific Characters.—Of a fairly deep yellow colour, tinged with red in the alimentary tract. Long and narrow; the rump and foot taper gradually from the end of the trunk, which is almost uniform in width. Corona is very wide relative to the body; about one-half wider than the collar, and more than one-fourth of the animal when creeping. Antenna is equal to nearly three-fourths neck width. Two lemon-coloured eye-spots on a small brain mass. Jaws not large, squarish; teeth, three large and one small. Foot has four segments. Spurs short, practically parallel, with short, straight interspace. Toes, four; two front ones stout and long, the other two quite small. Size, 1/50th inch.

This is a long, narrow animal which does not broaden out anywhere when creeping, and very little when feeding. It creeps with a sort of dead pull and progresses rather slowly. It swims very freely, as might be expected, seeing its home is in pools. The corona is most elegant and attractive, and is very wide-spreading. Corona, collar and neck are to each other as 35, 25 and 15, and in some cases the corona is as much as one-half wider than the

collar. The wheels are very shallow and practically circular in shape, and the rims bearing the cilia form complete circles except for the gap over the sulcus, which is very small owing to the slight depth (dorsal to ventral) of the sulcus. The sulcus (right to left) is wide and the bottom boundary of it is a sharp, thin ridge.

When the animal is feeding, the head is placidly swayed up and down and round about, each great wheel with its vibrant cilia flashing out brilliantly, in varying shades of yellow, as the incidence of the light changes ; now a circle, now some form of an ellipse. The effect is heightened by the lifting or screwing up, at times, of the outside boundaries of the wheels farthest from the sulcus, bringing them more towards the position facing each other, and foreshortening the view of the wheel. The cilia flash in great waves, and the whole effect is most striking and beautiful. When viewed from above, the discs give almost the best representation of two revolving wheels of any species.

Slight prominences on each disc bear two long setae. On account of the shallowness of the corona, the borders of the upper lip are very flat. The lateral borders have to rise very little from the collar to reach above the sulcus bridge. There they bend round at sharp angles between which the anterior border sags a little, so as to be slightly concave. The sulcus ridge, with its ends elbowing up into the discs, often shows over the upper lip, almost parallel.

Brushes of scrubby setae protrude from the long antenna. Two eye-spots, very distinct, are seated on the brain mass, which is of an inverted pear shape, well defined, but very small for such a large animal. Jaws of medium size, and rather square in outline, show on each side three large and clearly defined teeth and one smaller, not greatly larger than the striae, but whose point can be distinctly made out. Jaws and borders are often stained deep yellow.

The rostrum is stout and has a double lamella. From the posterior of the rostrum back to the end of the trunk, the width is practically uniform when creeping; there is just a gentle inward curve between the antenna and mastax. No swelling is visible in the lumbar region, its outline tapers gently into the foot, and this tapering is continued down to the spurs. At the ankle there is a slight sudden narrowing. The outside edges of the spurs

are practically parallel—the width at the ankle being 4·5, and across the spur points 5. A straight interspace, nearly half the width of the spur base, separates the short spurs, which are rather less in length than the width of the ankle. For a very short distance from the interspace, the inner border of the spur proceeds parallel to the outside edge, and then diverges straight to the apex. I have frequently seen the spurs clipped together in an inward direction, but have never observed the points farther apart than the normal. The spur segment is continued well back from the spurs to the toes. Very noticeable is the difference in size of the toes (fig. 5*b*), the front ones having at least twice the diameter of the back ones, and being much longer. About the middle of the toes, the diameter is greatest, and from there they narrow slightly to the extremities, which are terminated by peculiar cylindrical brushes. Muscular threads proceeding upwards from the toes are seen very distinctly.

The trunk is widely plicate.

Young specimens have seldom any yellow colour.

P. praelonga can be kept for a considerable time in the bottles, provided the water is renewed frequently; and the eggs hatch out. They do not seem to remain long healthy in an ordinary slide.

Habitat.—Draaifontein farm ravine, along with *M. falcatus*; also abundant in some of the pools in the larger ravine below.

Philodina grandis sp. nov.

Pl. 3, figs. 3–3*g*.

Specific Characters.—Body long and stout; bright yellow in trunk, but paler towards extremities. Corona very large and widespread, equal to well over one-fourth of the fully extended animal. The sulcus is nearly as wide as the disc. A stout peg on each wheel carries at least three setae. Rostrum stout, with trifid lamella. Antenna long and stout, equal to one-half of neck width. Jaws very large, heart-shaped with four very large teeth and one smaller. There are no eye-spots. Foot is long and fairly stout. Spurs narrow and equal to width of ankle, with narrow convex interspace. Two of the toes are very large. Trunk and rump are very closely stippled. Size, 1/50th inch with frequent samples up to 1/40th inch.

This is the species of Philodina referred to by Murray (10), who gave some figures of it. The colour is sometimes light lemon, but usually is bright yellow in the trunk. The ovary frequently shows a red tinge. It is a very large and powerful animal, one of the largest of the moss-dwelling species; and though not very much longer than *P. praelonga*, is much more massive. It quite rivals *M. russeola*, but is not quite so heavy in the rump and foot. It creeps very steadily with long strides, planting the toes well up under the head, and without any jerky action. When feeding, it keeps on ceaselessly swaying the head round about, and up and down, in a very lazy sort of way, so that the focus is being continually slowly altered.

The corona is of very great size—up to 1/135th inch in the largest examples—it is larger, and even more striking and handsome than that of *P. praelonga*, with equally circular discs. On account of its wheels being so round and wide, and the ciliated rims standing out so clear of the pedicels, there is presented the most perfect illusion, in any rotifer, of two cog wheels in motion. There seem to be about fifteen cogs or triangular bunches of cilia on each wheel. Some friends, on being shown the wheels, could hardly be persuaded that there was no rotation. The corona, collar and neck are to each other in the proportions 45, 30 and 20.

On each wheel is a stout peg bearing a bunch of, at least, three long setae. On the ventral side of the sulcus, just between the pedicels, there is a ridge or membrane with a deep gap, which evidently exercises a selective action on the particles streaming past. The sulcus is nearly as wide as the disc, but the discs lie so close on to the sulcus that the great cilia play in and round it in such a way as to interfere almost completely with a view of the borders of the upper lip, and to make the sulcus look narrower than it really is.

The pedicels move independently of each other; one wheel may be seen being twisted round or bent over, while the other retains its position. Both wheels may be turned over in the one direction, till they appear to revolve in parallel planes. Sometimes they are pushed towards each other till the straight front margin of the upper lip becomes a deep serrated V. A very common position is with the extreme ends of the corona bent, symmetrically, well down.

At the first glance the upper lip seems a very simple one, but to

realise all its intricacies takes a prolonged inspection, aided by a good deal of luck in getting the animal to turn its wheels in particular directions, so that views may be had under the great cilia which lash down into the sulcus, especially just under the dorsal termini of the primary and secondary wreaths. When the head is in the usual position it is practically impossible to see the corners under these termini.

The secondary wreath is well developed, and passes round, laterally, on a considerable projection which is continued lower down towards the neck. The lower boundary of the latter projection continues round dorsally (still standing out) to the sulcus in a wavy curve, and just under the end of the secondary wreath, bends down and round in a tongue-like part (Pl. 3, fig. 3*g*), and is continued in a large scalloped curve *s* round and up to near the corner of the upper lip. All round the lower rim of this projection, the tongue part, and the scalloped curve, is a narrow, glaucous, fleshy-looking band. This cannot be considered part of the upper lip, I think, as it does not start from what is usually considered the collar. Just below the lateral projection is the collar, and from it there proceeds a band *r* (placed lower in the figure than its real position to show more clearly), usually shadowed or covered by the projection above. When the wheel is screwed up and forward, the band can be traced up to the middle of the tongue part *t* already mentioned. There it seems to stop, but as it looks to be at a lower level, it evidently passes under. From the front corner of the upper lip there passes back a thin fleshy border—highest in the middle—down close to the other side of the tongue part. This is apparently continuous with the band already traced to the under side, but a good view is very rarely had owing to the play of the coronal cilia, and even at the best is not quite free of interference. This band, then, which apparently passes under the tongue part, is evidently the border of the upper lip, whose front margin is nearly as wide as the sulcus, and practically straight.

There is another line which starts from the collar alongside the first, and half-way towards the sulcus begins to widen out into a broad band *u*, which passes close to, and is often in contact with, the tongue part, and then bends across immediately in front of the rostrum. This band does not seem to lie flat, but is raised a little anteriorly.

The rostrum is stout and has four or five setae on each side, two of the longest have bulbous roots and are quiveringly vibratile. The lamella is trifid (fig. 3*f*), but only so seen when the rostrum tip is fully exserted, and pressed firmly against the cover-glass preparatory to pulling it away. Murray (10) states there are two separate lamellae, but the appearance of two is due to the middle part being hidden when the tip is only just showing. Before the grip of the glass is taken, the lamella is clearly seen with a fold in the middle, and not two separate parts. When the rostrum is tossed back, it has a peculiar appearance—two roundish parts in an almost rectangular casing.

There is a curious ribbon of thin skin, of considerable width, extending forward from the posterior of the rostral segment, and right round, at least dorsally and laterally. It stands clear of the segment at its front. Murray's figure seems to show it.

The antenna is stout and long, and equal to one-half of the neck width. There are three knobs across the top, and three brushes of short setae protrude; muscle or nerve threads pass up the middle. It is independently motile and it frequently gives a decided bend, the top segment also does so by itself. It is evidently very sensitive; for preparatory to exserting the head when the body is contracted, the antenna is gently protruded, and if it should meet an obstacle is drawn back, but again a second or even a third time it may be quietly pushed up to the obstacle, as if to ascertain its nature. The animal has evidently two very sensitive feelers: the antenna, and the cilia with the bulbous roots in the rostrum.

There are no eye-spots on the medium-sized brain mass.

The jaws are extremely large—1/520th inch—and somewhat heart-shaped; and the borders are thickened with rough brush-like extensions (Pl. 3, fig. 3*b*) often stained bright yellow. The four large teeth are pointed, and of a peculiar shape—swollen towards the inner ends and tapering off outwards. The fifth tooth is quite half the size of the largest, and the striae are very large. The double fulcrum (Pl. 3, fig. 3*e*) can be seen, during feeding, when the jaws are horizontal and open.

The vascular canals are prominent in the neck and are surrounded by a large amount of floccose matter, and there are at least five vibratile tags on each side. There may possibly be more, as the internal structure is not easily discernible on account of

the refractive, muscular, thick, fleshy integument, the deep plicae, and the small oil globules in the stomach investment. There are also minute round particles, like those so common in Floscularia, floating in the perivisceral fluid and streaming with every movement of the body. These often collect at parts and cause a reddish-brown appearance.

The rump is fairly long, but the anal and pre-anal segments are not well marked off from each other; the lumbar plicae, however, give some idea of how far the pre-anal segment extends (Pl. 3, fig. 3*d*). The intestine and contractile vesicle are thick-walled, but not particularly large for the size of the animal. Heavy foot glands and muscles penetrate through the anal segment; and two curious muscles seen over the contractile vesicle (fig. 3*d*) are apparently part of it, as they are pushed on to each other as the vesicle contracts.

The foot is longer than usual in the moss-dwelling Philodinae. There are four segments, through which pass two great glands and strong muscles. The spurs are characteristic, the interspace is slightly convex and equal to the width of the base of the narrow spur. The length of the spur is equal to the width of the segment at the point of attachment, but the spurs are attached not to the widest part of the segment, as is usual, but below it. I have never seen the form which has spurs exactly like *M. russeola* as figured by Murray. The toes are not far separated, the front two are enormous, and the other two much smaller. Cord muscles from each toe are very distinct, whether taut, or slack in loops.

The body is stippled in the most delicate and beautiful way. The stipples are exceedingly small and are arranged in rows so close together that, viewed at certain angles, as against the inside of a ridge, these rows look like delicate striae on a dental bulb. When the surface is viewed at right angles, the stipples are seen to be minute dots arranged in rows excessively close together. When the focus is slightly lowered, the appearance is that of hollows or tiny cells, and lower still the dots reappear. The middle focus—in good specimens—gives a brilliant effect, the perfect similitude of a miniature honeycomb whose cells have been reduced to almost infinitesimal dimensions. The stippling is difficult to make out on some specimens, but in general it is quite easy. Occasionally it can be seen most brilliantly on a dead shell or skin.

Philodina grandis is found in enormous numbers, occasionally, in isolated small pieces of moss. When there happened to be many on a slide, it was generally found that after a time they managed to congregate together in groups, as if fond of company. I have had as many as two dozen in view at once under the one-inch objective. They were lying stretched over and all about each other, some on moss with their heads down, others below with their heads stretching out, and nearly all feeding at the same time. Their coronae, all unfurled, swaying here and there, formed in the artificial light a most entrancing sight, flashing golden yellow amidst the green moss, and setting particles floating about in a perfect whirlpool. They seemed to take no notice when struck by a fellow Philodine, but decidedly objected to the impact of a swirling piece of moss.

Habitat.—Ground and rock moss. Uitenhage (Euphorbia Kloof), Grahamstown and Somerset East. Widespread and very numerous in isolated fragments of moss.

Philodina childi sp. nov.

Pl. 3, figs. 4–4*b*.

Specific Characters.—A very large and remarkably bulky Philodina; trunk of a dark brownish appearance. Rostrum stout. Antenna rather less than half the width of the neck. Trunk quadrate. Foot short and narrow—of five segments. First segment has two spurs set near each other. Toes four, short. Corona very large. Jaws large, teeth $\frac{1}{4}$ 2 $\frac{1}{4}$. Very delicately and clearly stippled. Size 1/40th inch.

This is, I think, the largest Bdelloid I have seen. I took it, for some time, for an overgrown variety of *M. quadricornifera*, as there is a considerable resemblance in general appearance. To my great surprise, however, when I observed it, after a time, creeping with its foot against the cover-glass, I discovered that it had four toes, and so was not a *Macrotrachela* after all.

Its length and bulk are both remarkable. It has a strong, thick muscular integument so that its shape retains wonderful uniformity, and varies little in outline. The lumbar region and posterior trunk are rather dark in colour, and almost opaque. It is a slow, laborious creeper and feeds freely. The rostrum is stout and has a large double lamella, each side of which has three

straight setae which quiver, but do not lash, and some shorter ones which were not seen to quiver.

The antenna is stout and fairly long, and the brain mass is small, far back and without eye-spots. Flocculent matter surrounding the vascular canals makes them very prominent in the neck. The jaws are elongated and bear four teeth on each side; two of these are very broad and large, and two—one on each side of the large ones—smaller but considerably larger than the extraordinarily large striae, and with well-defined points.

There are three ventral nucleated glands under the mastax, probably gastric. Two or three decided lateral ridges can be seen on the trunk, but there is no wrinkling when creeping. Quite characteristic is the shape of the lumbar region with stiff borders, and the anal and pre-anal segments not well marked off from each other. A long and convoluted stomach ends in a round and not very large intestine. The contractile vesicle is large and of fairly short period when feeding, and when it contracts crumples in towards the middle slowly. For so big an animal the foot is narrow; the spurs on the first segment are flat and triangular, and set very near each other. Somewhat similar to those of *M. quadricornifera* are the ordinary spurs, but less deeply cut between the tips, and more approaching a straight line. The four toes are short and stubby and not far separated from each other, the front two are the thicker (fig. 4*b*).

The corona is very wide-spreading and well over one-fourth of the length of the fully extended animal, and nearly as wide as that of *P. grandis*. The sulcus is slightly narrower than the wheel. A thin ridge or membrane with a V-shaped gap was seen ventrally between the pedicels, similar to that in *P. grandis*. Corona, collar and neck are to each other as 43, 31, 24.

The striking upper lip is rather complicated and will be best followed from the figure (Pl. 3, fig. 4*a*). No central setae were noticed on the wheels. *P. childi* is stippled in a manner precisely like *P. grandis*; the stippling is equally beautiful, with the same honey-comb appearance, and it is never difficult to make out; the trunk, lumbar region and spurs are the parts stippled.

An egg, very large, broadly oval, and dark in colour, was deposited on the slide five days after the animal was enclosed, and the division of the cells watched for some time.

There is another animal almost as large, which I have thought

might prove to be a variety of *P. childi*. It has a different upper lip, though it resembles it in several details, but I was unable to study it sufficiently.

Habitat.—Grahamstown. Very rare. Mr. Child, formerly of Uitenhage, used frequently to bring me moss from different places, and on one occasion brought the small piece of moss from Grahamstown which contained this animal, and I have named it after him.

I have never met with *P. childi* since, though I have had moss very frequently from Grahamstown.

Philodina nitida, sp. nov.

Pl. 5, figs. 9–9*a*.

Specific Characters.—Trunk rectangular; occasional specimens attain a large size. Lumbar region and foot rather light. Colour yellow, fairly deep in the older specimens. Furrowed longitudinally, but has a very smooth skin. Two large lemon-yellow eye-spots. Antenna long, between one-half and two-thirds neck-width. Jaws very large, with three great teeth and a fourth just smaller. Spurs of similar shape to those of *P. rugosa*, but held at different angles. Corona large; sulcus rather less than the disc; upper lip clear cut, distinctive. A seta on small pimple on each wheel.

Size, first samples, 1/70th inch, later examples up to 1/50th inch. This is an attractive, neat and dapper animal, modelled and built on clean lines, and has a clear, smooth skin giving a brilliant shining appearance. In the large specimens the colour is a deepish yellow all over, except the foot and lateral plicae, which latter are glassy-looking and fleshless. Frequently the deep shade occurs only in the alimentary track. Ovaries were seen of a pink tinge, and occasionally the wheels showed saffron.

It has a double lamella, rather small, and not so transparent mica-looking as usual; attached to the base of the lamella is a fleshy rim, also double, on which are situated a considerable number of setae, hardly, except two, projecting beyond the rostral sheath. These two and other two have bulbous roots, and have a quivering motion. The neck is very heavy and widens considerably at the dental bulb.

Scrubby setae are borne on the long antenna, whose two seg-

ments are nearly of equal length. Very large jaws—1/780th inch —carry four teeth each ; three are very large and the fourth only just smaller ; the striae are also large.

A good presentment of a fox's face is given by the brain mass, with its two large eye-spots. The trunk is rectangular—not much longer than broad in the earlier examples found—and has deep and numerous longitudinal furrows. The lumbar region is comparatively light for such a large animal, and has a thick-walled intestine, oval and very long ; and a contractile vesicle which is fairly large.

The foot consists of four segments, and has spurs which are not unlike those of *P. rugosa* in shape, but more bent and decurved. Each spur is as long as the width of the ankle ; a straight or scarcely perceptibly convex interspace separates the spurs, and is almost equal to twice the width of the spur base. The spurs seem to be feeble, and in all the earliest specimens one was twisted and not symmetrically placed with the other. Afterwards, the commonest form had the two spurs parallel, the outside border of one convex and the other concave. In one or two of the large examples last seen, the spurs were both convex on the outside borders.

No great distance separates the toes ; the front ones are thick and fairly long, the back ones thin and short.

A large and well-developed corona is one-fourth of the length of the fully extended animal, and bears long cilia which play in great waves. In one giant example the corona was 1/180th inch wide, but the average width was about 1/250th inch. The proportions of the corona, collar and neck, are to each other in average specimens as 25, 20 and 15. The upper lip is distinctive. A lobe from the wheel meets the highest point of the upper lip ; and occasionally a tooth jag or two show in the middle notch, but probably belong to the sulcus. A seta rises from a pimple on each wheel.

It creeps at a fair speed, and sometimes hitches the foot round and forward, with a swing. It feeds freely and usually lies back over the foot when feeding.

A long tongue-shaped gland lies below the mastax, ventrally. Heavy foot glands run high up into the anal segment.

Habitat.—Ground moss, the Hatchery, Stellenbosch. Found in fair abundance.

Philodina nitida var. *decens*.

Pl. 5, fig. 10.

This animal differs from the species in several points, but comes sufficiently near in jaws, upper lip and spurs to be considered a variety.

It is of a very elegant shape when creeping. It is large and stout, and has a heavy neck and fairly heavy rump. There is a large brain mass with two large yellow eye-spots.

The foot is short, and contains heavy glands. The spurs are in shape like those of *P. nitida*, but symmetrically placed; and of the toes two are large, and the other two much smaller. The rostrum is stout, and the double lamella, which is not very easily seen, bears several stiff setae. The antenna is rather thin and about one-half the neck width.

The teeth are exactly like those of *P. nitida*, and the striae are very large and easy to count—10 behind the teeth. There is a long tongue-shaped gland below the mastax.

There is little distinction between the anal and pre-anal segments. The intestine is oval and very long.

The corona is large and beautifully balanced; and the proportions of corona, collar and neck are to each other as 30, 20 and 15. The upper lip consists of two rounded lobes with a fair interspace. The wheels are frequently screwed, or brought nearer each other, causing serrations in the upper lip interspace. There is a slight prominence bearing a seta on each wheel.

The colour is faint pink and in some pale yellow. The pink colour is little more than a tinge, but the changing shades are wonderfully fine, as the animal doubles up and shows greater or less depth of flesh at parts, especially in the dental segment. Size, 1/50th inch.

Habitat.—Stellenbosch in ground moss.

Philodina inopinata sp. nov.

Pl. 4, figs. 6–6*b*.

Specific Characters.—Of small size, with long narrow foot, narrow cylindric trunk and stout neck. Antenna slightly longer than neck width. Of a glaucous colour. Two eye-spots. Teeth, three. Foot has five segments. Spurs of medium length,

narrow, almost parallel. Toes short. Corona scarcely wider than collar, sulcus narrow, upper lip triangular. There is a rectangular flap-like projection at the anus, which works as if on a hinge. Size, 1/90th inch.

The upper lip of this species is most difficult to examine, as the animal when feeding nearly always stands upright on its toes, and whirls round and round on its vertical axis; or swims about at great speed. It is a very timid feeder when moored, the corona is unfurled and almost instantly closed again, and this is repeated again and again, so that the merest glimpse of the upper lip is had. The corona is scarcely wider than the collar; the collar rises high up, and the pedicels are very short, causing some interference between the cilia of the primary and secondary wreaths. The upper lip is of an uncommon shape for *Philodina*. It is in shape a triangle extending as high as the discs, and lying well back into the sulcus. The stoutest part of the animal is that between the short, broad rostrum and the trunk—the dental segment is slightly the widest—and the trunk never gains the same dimensions as the neck, until after heavy feeding. It is a rather slow, deliberate creeper. The antenna is very long and generally hangs backward, with the terminal segment bending over, and when creeping gives a side view reminding one of that of a hare's head with the ears laid back. Some species of the genus *Rotifer* also have this appearance. Long setae are borne on the antenna, which is thickest half-way between the base and the second segment, as if swollen there.

There are brilliant eye-spots on the brain mass, well apart, slightly elongated and set obliquely. The trunk is closely plicate. Right from the trunk, the lumbar region and foot taper very gently all the way to the spurs.

Quite characteristic is a very peculiar process at the end of the anal segment. It is a thin, almost membranous, rectangular flap, somewhat bent in and over, on the top, so that the side view is that of a hook. When the animal is stretched to the full, the flap lies flat down, pointing forward over the contractile vesicle. As the animal relaxes, it stands upright, and turns down in the opposite direction when the foot is being planted. It almost seems as if the flap worked on a hinge. It is of the same colour as the foot, and thus easily overlooked. It was some time after finding the animal that I noticed it first.

The foot is a longish one of five segments, and bears on the penultimate segment spurs which are only just noticeably divergent, very narrow and acuminate, with narrow straight interspace, and equal in length to the ankle. The four toes are short and stumpy.

Habitat.—Draaifontein farm ravine pools, in company with *P. praelonga*. Found in abundance.

When I was examining the habits and characteristics of *P. inopinata*, I had rather a surprise on comparing my notes after having examined a good many specimens. The statements as to the spurs agreed fairly well, but those on the number of segments in the foot were sometimes five and sometimes four, on the number of the teeth sometimes three and sometimes two; and the length of the antenna was in some cases stated to be longer than the neck width, and in others shorter. In some, indications were noted of a triangular upper lip, in others not. It looked as if I had had, inadvertently, two species under observation. That there were two species turned out to be the case, but so alike in general appearance, habits, size and colour, that I had not even a suspicion of the fact until I noticed these conflicting details. Yet they are two very distinct species. *P. inopinata* has the spurs slightly more divergent, a longer antenna, one foot segment more, a tooth more, a narrower corona and sulcus, a different type of upper lip, and shorter toes. It has the flap near the anus, the other has not. It is quite extraordinary to find two species living together, so alike in general appearance and habits, and yet so distinct in almost every detail.

I have never met with *P. acuticornis*, but I think the second species referred to above might be considered a variety and I give a description under the name *odiosa*.

Philodina acuticornis Murray, *odiosa* var. nov.

Pl. 4, figs. 7–7*b*.

Specific Characters.—Neck short, trunk narrow, cylindrical; lumbar region and foot taper gradually from trunk to spurs. Foot consists of four segments. Spurs of medium length, practically parallel. Toes long, sharp, about equal in length, though possibly back pair rather longer. Eye-spots distinct. Antenna practically equal to neck width; with longish setae. Teeth, two

in squarish jaws. Corona rather wider than collar. Collar has flap extensions. Upper lip has a wide front gently sagging in the middle. Size, 1/90th inch.

Its habits when feeding are similar to those of *P. inopinata*, but if anything more provoking. The corona is rather wider, but the upper lip is more difficult to see, on account of its less sharp outline and its greater transparency. It rises about one-third up the sulcus. The rostrum is not very large, and the double lamella is far from prominent. The eye-spots are brilliant, somewhat elongated, and set rather closer together than those of *P. inopinata*.

The spurs are equal in length to the ankle width, and narrow to a sharp point, while the interspace is equal to the width of the spur base. Towards the points, the spurs curve upwards slightly but distinctly, a very uncommon occurrence.

It has a habit, when creeping, of throwing itself backward head over heels, with the four toes fully extended and gripping. Sometimes the two back toes are seen extended alongside and almost parallel to the spurs, and seem to be nearly as long (Pl. 4, fig. 7). All four toes are pointed.

This variety seems hardier than *P. inopinata* as it persists in the water and on the slides after the latter has died out, but loses much of its energy after a few hours on the slide.

Habitat.—Draaifontein farm ravine pools. Fairly abundant.

Philodina patula sp. nov.

Pl. 5, figs. 11–11*a*.

Specific Characters.—Stout, but not of great length. Colour lemon yellow, but only the merest tinge. Antenna equal to two-thirds neck width. Jaws not very large; teeth, two. Brain mass large, but no eye-spots. Lumbar region not heavy. Foot fairly stout, of four segments. Spurs parallel, very short, and without interspace. Corona very wide—almost twice collar width; sulcus rather wider than disc. Upper lip with a slight indentation. Size, 1/80th to 1/75th inch.

This is a vigorous animal and a very free feeder. The rostrum is long and stout, with a double lamella, and carries several long setae. The antenna is long and has a considerable tubular hollow

inside. The trunk laterally is slightly convex, and the posterior boundary always shows straight across with sharp corners. There are deep furrows laterally, the ridges not showing fleshy, but having a mica-like appearance; the dorsal furrows are broad and shallow. There is practically nothing to distinguish between the anal and pre-anal segments, which make up a comparatively light lumbar region. Both the intestine and the contractile vesicle are rather small. The foot is fairly stout, and the first segment is long and of a distinctive shape. It curves in and then out, ending in a distinct flange, which overlaps, laterally, the second segment. There are three of these flanges, and a good view can be had of them, when looking down the dorsal boundary, while the animal is feeding in a nearly perpendicular position. The first is at the posterior end of the trunk, and stands out very clearly; the effect is heightened by a broad hollow just in front of it. The second flange is at the back of the anal segment, and also stands well clear of the surrounding parts. The third is the one already described at the back of the first foot segment. They are very distinctive, and add to the general effect of the many graceful curves shown in the outline of this animal.

The spurs are very short, slightly blunt, parallel, and having an almost concave boundary between the tips.

The corona is an elegant one of large dimensions proportionately, the width being rather more than one-fourth of the fully extended animal. There is a single seta on each wheel, rising from a very small peg. Short pedicels support the wheels. The corona is to the collar as 22 : 13.

When the animal is feeding in a perpendicular position, and the upper lip looked down upon, the front margin of the latter shows two thick lobes, but when the animal is horizontal the anterior border approaches more nearly a straight line. This would seem to indicate that the lobes are much thicker, or deeper, laterally, and thin out towards the middle. There are two green granules in front of the rostrum, visible when the corona is unfolded.

The two teeth are not of great size. In some cases there is a third one, not much larger than the striae, but having a point which can be defined.

When the animal was anchored and feeding, the first two trunk segments were always seen with the peculiar frill arrangement shown in the drawing (Pl. 5, fig. 11).

The egg is a flat oval, with thirteen lateral prominences, or rather gentle swellings, three at the end are larger than the others. It is not unlike the egg of *P. plena*.

The only species at all like this one is *P. plena*. They are both tubby-looking animals when feeding, and have spurs and upper lips somewhat similar; but the peculiar shape of the foot and also of the first two trunk segments, the proportions of the corona, and the presence of the flanges, easily serve to distinguish *P. patula* from *P. plena*.

Habitat.—Ground moss, Grahamstown and Springfield Uitenhage district. Found abundantly, on one occasion only from each place.

Philodina rapida sp. nov.

Pl. 4, figs. 8–8*a*.

Specific Characters.—Of fairly large size; yellowish in colour. Heavy neck and lumbar region, with short stout foot. Antenna stout, and equal to one-half neck width. Teeth, three, medium size. Intestine very large. Foot consists of three segments. Spurs parallel and very short. Corona large with wide sulcus. Upper lip trifid. Size, 1/70th inch.

This species in general appearance is not unlike a *Macrotrachela*. Its heavy lumbar region and stout short foot chiefly contribute to the resemblance. It also creeps fairly fast after the style of a *Macrotrachela*. The rostrum is fairly stout and has several long setae, a double but rather small lamella, and cilia which have a habit of moving slowly when the animal is feeding. A thick antenna bears short stubby setae. There are three medium-sized teeth in the dental bulb, which is not very large.

The trunk is plicate and strongly muscular. Large glands extend through the foot and far up into the lumbar region. The intestine is extremely large, and the contractile vesicle of medium size, with a not very short period. The spurs are very short and parallel, with a concave line joining their tips. They very much resemble those of *P. patula*. The foot is very short, and of, apparently, three segments, and the toes are also short.

The corona is a handsome one, and large—about one-fourth of the extreme length of the body—while the sulcus is rather wider than the disc (7 : 6·5). Corona to collar is as 20 : 13.

The upper lip is broad anteriorly and has three lobes, or rather, small conical protuberances.

Habitat.—Rock moss, Euphorbia kloof, Uitenhage district. Rare.

Philodina proterva sp. nov.

Pl. 5, figs. 12–12*a*.

Specific Characters.—Of rather small size; glaucous in colour. Trunk heavy, but extremities rather light. Lamella fairly large and very transparent. Antenna short, about one-third of neck width. Brain mass large, without eye-spots. Dental bulb small with two medium-sized teeth. Lumbar region not very heavy; foot narrow and short, of four segments. Spurs very distinctive. Corona not wide-spreading, with sulcus about two-thirds of disc width. Upper lip wide in front and almost straight across. Size, 1/80th inch.

This is a very active and vigorous animal. It moves at very great speed, and is most restless, making it extremely difficult to examine. The trunk is not very transparent on account of the number of oil globules. It feeds voraciously—a perfect pig—and swells up into a barrel in a short time. It soon becomes so swollen and heavy that it has great difficulty in creeping, sometimes swinging right over sideways, as it tries to plant its foot forward. When feeding, it occasionally bunches part of the trunk forward, forming a constriction in the middle. The jaws work at such a tremendous pace, that one cannot even catch the flash of the teeth passing up and down.

Great circular muscles can be seen on the trunk and lumbar region, and some half-dozen longitudinal ones passing up into the cervical. The circular ones are very plainly visible, dorsally, over the ovary and eggs, but the stomach investment is too dense to show them well. There are some eight or ten in the trunk and lumbar region. The glistening of the muscles gives the trunk a very peculiar appearance in some specimens.

It has rather a short rostrum with great cilia. There is a large hemispherical granulated gland, attached to the posterior of the dental bulb. The contractile vesicle is large and of short period. The foot is short, and has four segments, the second and third being very short. Heavy foot glands extend far up into

the pre-anal segment. The spurs are convex on the outer borders and slightly divergent. There is a nick cut out in each inner border, and a bold convex interspace separates the spurs.

The corona is not wide, and not quite to collar as 5 : 4. Two membranes from the wheels come down into the sulcus, which is about two-thirds of the disc width. The upper lip is very difficult to trace, on account of its faintness, the refringent matter below and the rostrum generally overlying it. The restless waving motion also adds to the difficulty.

Habitat.—Ground moss, Salisbury, Rhodesia. Abundant in the one very small piece of moss I got from Salisbury. I have not seen it from anywhere else. It is very prolific. Along with this were two other species which had practically the same spurs ; one a variety of *M. quadricornifera*, and the other a variety of *M. musculosa*.

Philodina scabra sp. nov.

Pl. 6, figs. 13–13*b*.

Specific Characters.—Of extremely small size, short and stout ; of no distinctive colour. Trunk roughly furrowed, of gnarled bark-like aspect. Skin of trunk is evidently viscid, as particles adhere to the trunk. Corona narrower than collar, sulcus extremely narrow. Upper lip a flat curve with a small fleshy sharp peg-like protuberance in the middle. Antenna is equal to about one-half neck width. Foot short with four segments. Spurs are very distinctive and there are four on the penultimate segment. The dental bulb lies well back, and bears two teeth. Size, 1/180th inch.

This extremely minute animal, in general appearance and in details, corona and foot, looks much more like a species of *Macrotrachela* than a species of *Philodina*. I have it, in my notes, included among the *Philodina*, but have not made a distinct statement about the number of toes, as I usually do. I evidently, from my figures, did make out the number, but unfortunately omitted to state it, and as I have not seen the animal since 1908 I cannot now remember about the number of toes ; or whether it could have been placed among the *Philodina* by a slip, though I hardly think so. When the number of its toes is next made out, it may mean transfer to *Macrotrachela*.

It is rather slow in its movements, and prefers to keep under the rubbish, so that it is most difficult to find one when searching for it. It is practically a matter of chance to find one, even when one has got the moss containing it, as it is so small and generally has rubbish adhering. Evidently there were very few in the moss.

It is of shuttle shape, but not slender. The rostrum is fairly stout, with prominent setae under the double lamella. The rump and foot are stout, but do not give a heavy appearance. On the usual spur-segment there are four spurs of moderate length. The upper two are broad at the base and narrow to sharp points, and have an outside convex bend. Just below this pair, and a little inside, are two other spurs, about the same length but narrower at the base, gradually narrowing to sharp points, and straight. This is the only example of a Bdelloid having four spurs on one segment.

The corona is slightly less wide than the fairly prominent collar, and has an extremely narrow sulcus, and short pedicels. The upper lip is rather a flat curve rising up in the middle into a minute fleshy spike.

Habitat.—Tree moss, Van Staaden's pass, Uitenhage district. Rather rare.

Genus MACROTRACHELA.

Macrotrachela petulans sp. nov.

Pl. 6, fig. 14.

Specific Characters.—Of moderate size, but stoutly built. Colour hyaline, with pellucid granules on trunk, not very close together. Corona equal to collar, and sulcus to four-fifths of disc. Upper lip rounded, bifid with gentle dent. There is a seta on each wheel. Antenna stout, equal to one-third neck width. Jaws squarish; teeth three, large and well apart. Stomach a wide oval; intestine very large, oval. Foot stout, short, of three segments; last segment expanded into thick circular disc, wider than ankle. Spurs very small, divergent, with wide interspace slightly convex. Size, 1/90th inch.

The most outstanding feature of this sturdy little animal is the large, prominent, thick-walled, perfectly oval stomach. I have

seen nothing like it in any other Bdelloid. The wall is not rigid, nor strong enough to prevent it wrinkling when empty. It evidently discharges the contents under the shock of being placed on the slide, but before the slide can be examined all the specimens, perhaps dozens, are feeding vigorously, and soon are practically buried under a cloud of floccose matter. In less than a quarter of an hour the stomachs are all showing up as regular ovals, fully as broad as one-half the trunk width, each oval perfect and extending from mastax to intestine. Sometimes when Infusoria are devouring the contents of a dead specimen, the stomach and intestine, then evidently rigid, can be seen being knocked about, like a full-blown bladder with a smaller one attached, the walls quite distinct with a narrow connection between the two. This connection seems to be a thick muscular stricture of the walls of the stomach and intestine. When the stomach empties, the walls sag in; and when feeding again takes place, the walls behave pretty much as those of an elongated bladder when being slowly filled with air. After being a few hours on the slide the animals grow sluggish, seldom move away from their position and feed little. Some I could persuade to begin feeding at once by the addition of a little water.

It is a steady, fairly fast creeper, and with long strides plants its foot well under the head, and without any jerking.

The rostrum is short, but not particularly so. The lamella is double, but not very prominent, and being very diaphanous is not easily seen. There is a raised part surrounding the antenna, and sloping down to the lateral borders of the segment, and the antenna protrudes only a short distance outside this.

There is a large wide brain mass. The teeth are quite large, widely separated, and easily defined. In no specimen did I ever see any departure from three as the number of teeth.

The trunk and rump are granulate with not very large granules, which are pellucid or pearly-looking and accordingly not very conspicuous, nor difficult to overlook. These granules are not very close together and are rather irregularly arranged.

The lumbar region is fairly heavy, but not swollen-looking, and the contained contractile vesicle is round and very large; and when expanded fills up practically the whole of the anal segment. The spurs are very small and very divergent. In some positions, the interspace forms practically a straight line with the inferior

borders of the spurs, but usually the wide interspace curves just enough to appear convex.

The corona is bold, with a sulcus equal to four-fifths of the disc, and the relative proportions of the corona, collar and neck are 11, 10, 8½. The rounded upper lip has a gentle depression in the front margin, and just covers the bridge of the sulcus when the animal is horizontal. There is a small fleshy tooth in the sulcus, generally hidden, and two membranes come down from the wheels to near the middle of the sulcus bridge. There is a distinct lip flap at the collar.

The only Bdelloid at all near to this is *C. asperula* Murray (8). In general appearance and in some details they are very similar. *M. petulans*, however, has a distinctly different type of spurs; has not got an exceptionally short rostrum; has not the sharp points on the upper lip, nor any peculiar shape of the first trunk segment. It has a visible lamella, and the teeth never were found to vary in number from three; nor do the jaws show any constriction. The most essential difference, however, is in the character of the stomach. Murray had evidently paid particular attention to the width of the lumen, as shown in his descriptions of *C. armillata*, *C. lepida* and *C. microcornis* (7, 9). Having thought it worth while to note these not very greatly enlarged instances, he was not likely to have overlooked such a departure from the common, had it existed in *C. asperula*. With regard to *C. asperula* he neither mentions nor shows in his figure a wide lumen; besides, he had previously seen my sketch of *M. petulans*, and would have kept an outlook for this distinctive feature.

Habitat.—Tree and rock moss. Widely spread and abundant at times. Grahamstown; Uitenhage district at Bulk River, Springfield, Van Staaden's pass and Draaifontein farm.

Macrotrachela cuthberti sp. nov.

Pl. 6, figs. 15–15*b*.

Specific Characters.—Of moderate size, and rather under medium stoutness. Antenna very short, equal to one-fourth neck width. Jaws small, square with three strong teeth. Contractile vesicle large. Foot short, of apparently three segments. Spurs small, sharp and scarcely divergent. Corona just visibly

wider than the collar. Sulcus narrow. Upper lip quite distinctive. Size, 1/90th inch.

This is a vigorous, active animal and feeds freely, and is of a pale hyaline colour. It is of a semi-muscular type, for while the muscular integument is sufficiently strong to keep a fairly regular shape when creeping, yet occasionally the trunk loses its ovoid form when feeding.

The corona is bold and handsome. It is hardly wider than the collar, has a narrow sulcus and rather high pedicels. It is difficult to get a good view of the upper lip on account of its smoothness and glassy colour, and of the restless habits of the animal. The part of the upper lip which rises up from the flat curve looks somewhat like two stout rose thorns set against each other. The small tooth process in the middle of the curve between is not always seen, and this probably indicates that it is on the sulcus bridge. Lateral flaps are seen at the collar, and there is a large oral entrance with a spout-shaped under lip.

The rostrum is fairly stout, and the double lamella prominent. The antenna is very short, about one-fourth the neck width, and almost as broad as long. Quite characteristic is the small, square dental bulb, with very broad, thick even outline or borders, and it carries three strong, thick teeth set well apart.

The rump is not heavy, and the pre-anal segment has a wrinkled mark on each side. The contractile vesicle is very large. The foot is short, and its spurs are sharp and practically not divergent. From tip to tip, the outline is a rather flat concave, but at times the appearance is of two short cones with a short, straight interspace.

Habitat.—Fairly common in ground moss from Stellenbosch and Mulder's Vlei.

I have named this species after Mr. J. R. Cuthbert of Stellenbosch, who kept me supplied with moss from his neighbourhood.

Macrotrachela macmillani sp. nov.

Pl. 6, figs. 16–16*a*.

Specific Characters.—A plump little animal, of glaucous colour, with a slightly yellowish stomach investment. Each longitudinal ridge on the trunk has four deep bends in it; these deep dents seem to connect crosswise, giving the appearance of five

transverse rows of tiles or overlapping plates on the trunk. Rostrum very stout. Antenna short, about one-third neck width. Teeth, 3/4. Foot of four segments. Spurs short, sharp with wide, flat interspace. Corona slightly wider than collar. Upper lip has a broad front margin with a gentle indentation. Size, 1/100th inch.

This little animal has a most extraordinary yet attractive appearance. Viewed from the front and looking downwards, the trunk seems protected with five transverse rows of tile-like parts overlapping posteriorly. These parts are not excrescences, or foreign to the trunk as in *M. incrassata*, but the true skin, ridged and bent into these little oblongs, as is made apparent by the alteration of their shape with every movement of the body, especially when creeping. If looked at sideways, when the animal is feeding horizontally, the dorsal crests and hollows can be seen, and it can be noticed also that the borders of the crests, instead of curving down gradually to form the hollows, suddenly bend straight down or even backwards, causing the appearance, already mentioned, of tiles overlapping. The top edges or rims of the ridges are easily focused, and are of a glaucous green colour, contrasting sharply with the grey between. These loops appear also on the rump with a little variation, but of a permanent character, and are triple in the anal segment.

M. macmillani is a fast creeper, with a short glide or slither with each step; and it feeds freely and quietly.

The rostrum is stout with a double lamella which stands out clearly. The antenna is short and exceptionally broad at the base. The jaws are not very large, are winged and have three teeth in the one and four in the other. When the animal is creeping, the neck shows quite a distinctive shape. There is a gradual curve from the rostral to the dental segment, the narrowest part being about half-way between.

The rump seems to have three divisions, but not very markedly so, and it is somewhat doubtful what belongs to the anal and what to the pre-anal segments, though probably the anal is very large and consists of two of these apparent divisions. The intestine and contractile vesicle are both large. The spurs are short with a wide, flat interspace. There is a short foot of four segments, and on the last segment there is a ring expansion, but not large enough to show outside the ankle, as in *M. petulans*.

The corona is bold, and has a sulcus rather wider than half the disc, and the proportions of the corona, collar and neck are to each other as 10, 9, 7.

The upper lip rises above the sulcus bridge, has a broad front, with rounded corners and a shallow indentation in the middle. There is a thick, short, fleshy tooth in the sulcus.

The trunk is stippled.

The egg is broadly oval, with round knobs somewhat like those in *P. plena*, but more numerous—about fourteen.

Habitat.—Rock moss, Grahamstown. On the first occasion when I found this species I saw only some three or four, and put my notes aside, lest it should prove a freakish or unstable variant; but on a second occasion it was found in great numbers, and frequently as many as a dozen were seen on a slide. It does not seem, however, to be widespread, as out of the large number of pieces of moss examined only one small piece on each of the two occasions contained any.

Professor Macmillan, Grahamstown, sent me the moss on both occasions, and I have named the species after him.

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DESCRIPTION OF PLATES.

Plate 2.

Fig. 1. *Monoceros falcatus*, side view.
,, 1*a*. *Monoceros falcatus*, dorsal.
,, 1*b*. *Monoceros falcatus*, head, ventral.
,, 1*c*. *Monoceros falcatus*, jaws.
,, 1*d*. *Monoceros falcatus*, toes and spur, ventral.
,, 2. *Didymodactylos carnosus*, dorsal.
,, 2*a*. *Didymodactylos carnosus*, corona.
,, 2*b*. *Didymodactylos carnosus*, spurs, and toe orifice.
,, 2*c*. *Didymodactylos carnosus*, toes exserted.

Plate 3.

Fig. 3. *Philodina grandis*, dorsal, feeding.
,, 3*a*. *Philodina grandis*, ventral, creeping.
,, 3*b*. *Philodina grandis*, jaws.
,, 3*d*. *Philodina grandis*, rump, dorsal.
,, 3*e*. *Philodina grandis*, jaws after treatment with potash.
,, 3*f*. *Philodina grandis*, lamella and setae.
,, 3*g*. *Philodina grandis*, left side corona, more enlarged.
,, 4. *Philodina childi*, dorsal.
,, 4*a*. *Philodina childi*, corona.
,, 4*b*. *Philodina childi*, toes and spurs.

Plate 4.

Fig. 5. *Philodina praelonga*, dorsal, feeding.
,, 5*a*. *Philodina praelonga*, dorsal, creeping.
,, 5*b*. *Philodina praelonga*, toes extended.
,, 6. *Philodina inopinata*, dorsal, feeding.
,, 6*a*. *Philodina inopinata*, dorsal, creeping.
,, 6*b*. *Philodina inopinata*, jaws.
,, 7. *Philodina acuticornis* Murray, var. *odiosa*, dorsal.
,, 7*a*. *Philodina acuticornis* Murray, var. *odiosa*, jaws.
,, 7*b*. *Philodina acuticornis* Murray, var. *odiosa*, toes extended.
,, 8. *Philodina rapida*, dorsal.
,, 8*a*. *Philodina rapida*, corona.

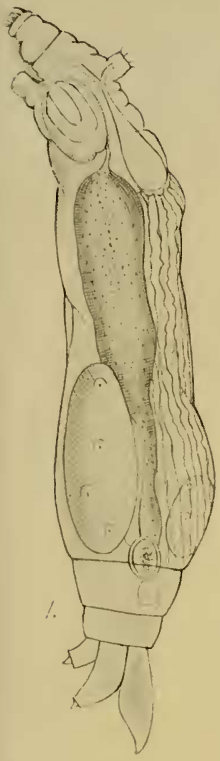
Plate 5.

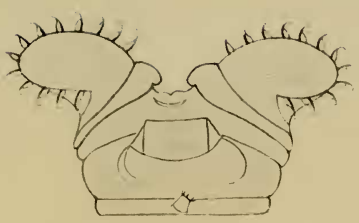
Fig. 9. *Philodina nitida*, dorsal, feeding.
,, 9*a*. *Philodina nitida*, dorsal, creeping.
,, 10. *Philodina nitida*, var. *decens*, corona.
,, 11. *Philodina patula*, dorsal, feeding.
,, 11*a*. *Philodina patula*, dorsal, creeping.
,, 12. *Philodina proterva*, dorsal, creeping.
,, 12*a*. *Philodina proterva*, corona.

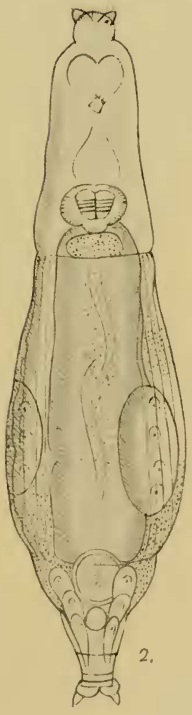
Plate 6.

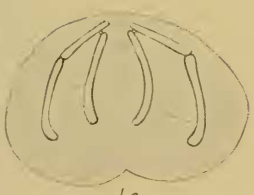
Fig. 13. *Philodina scabra*, dorsal, feeding.
,, 13*a*. *Philodina scabra*, spurs, dorsal.
,, 13*b*. *Philodina scabra*, spurs, side view.
,, 14. *Macrotrachela petulans*, dorsal.
,, 15. *Macrotrachela cuthberti*, dorsal.
,, 15*a*. *Macrotrachela cuthberti*, corona.
,, 15*b*. *Macrotrachela cuthberti*, jaws.
,, 16. *Macrotrachela macmillani*, dorsal, feeding.
,, 16*a*. *Macrotrachela macmillani*, dorsal, creeping.

Where proportional numbers are given in the text, each unit represents 1/6000th inch.









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BDELLOID ROTIFERA OF SOUTH AFRICA.

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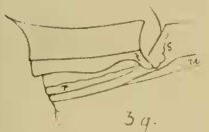

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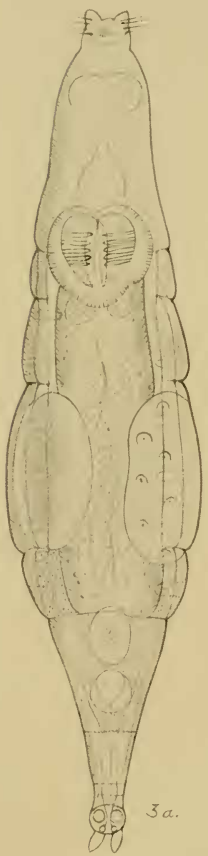

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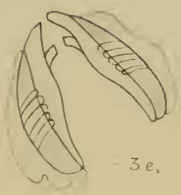

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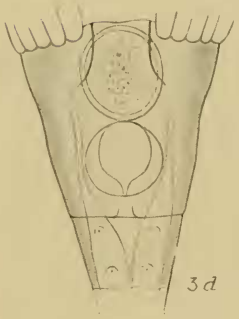

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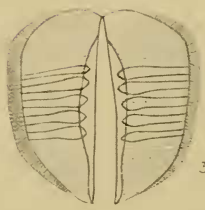

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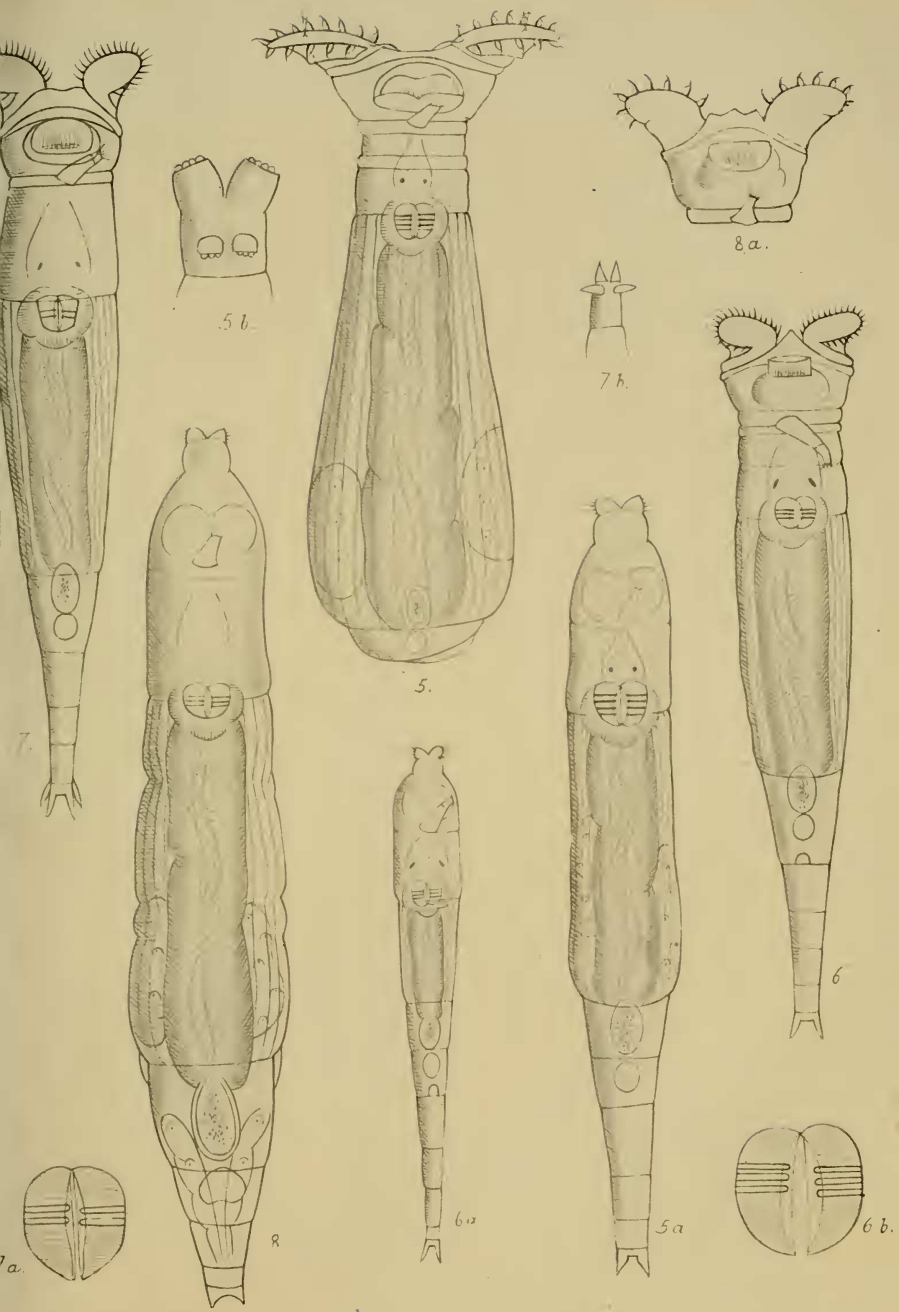
J. Milne del. ad. nat.

Bdelloid Rotifera of South Africa.



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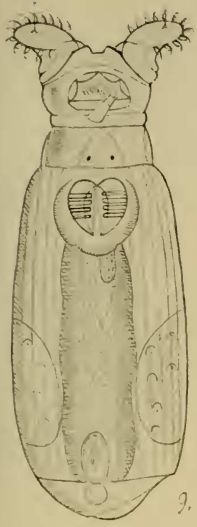

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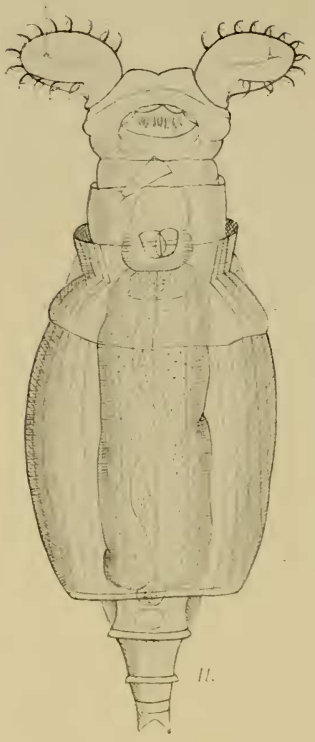

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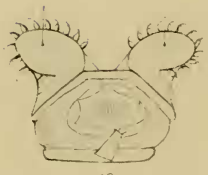

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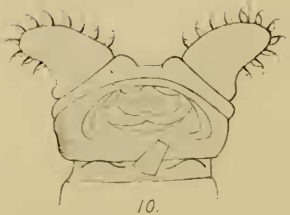

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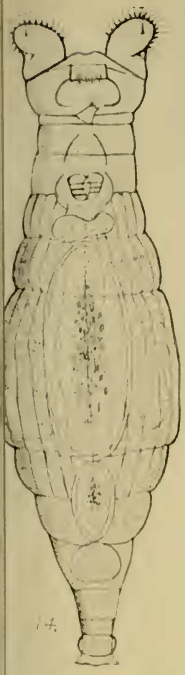
Bdelloid Rotifera of South Africa.



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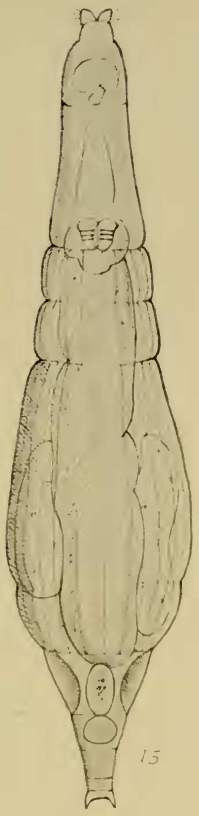

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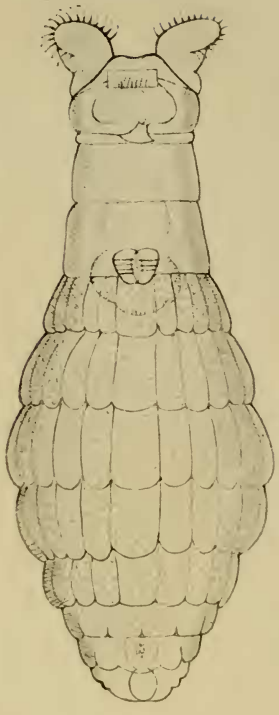

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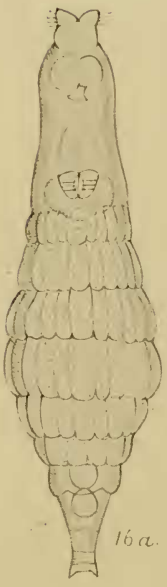

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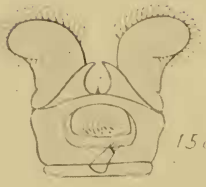

15a.

W. West, del. ad nat.

BDELLOID ROTIFERA OF SOUTH AFRICA.